SEAMLESS TECHNOLOGY TRANSFER VIA STRATEGIC PARTNERING BETWEEN STATE TRANSPORTATION AGENCIES AND ACADEMIC/RESEARCH INSTITUTIONS

by

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ABSTRACT

Rapid changes in technology are challenging most agencies that wish to remain efficient in the delivery of their technical services. Agencies providing transportation infrastructure, operations and services are not an exception in this case. There is an increasing need for research, development and technology transfer (RD&T^2) services by these agencies. How they procure RD&T^2 services efficiently has been of great interest to top management personnel of such agencies. Since most transportation agencies are government entities, procurement of goods and services must follow strict procedures that ensure transparency (accountability), fairness and objectivity in the awards. However, these procedures have often slowed down the process of procuring RD&T^2. The time taken from problem statement to contracting and project execution has often been too long, thereby making such agencies slow to acquire RD&T^2 services and to keep abreast with the fast-changing technology. Therefore, the question has been: are there mechanisms that would speed-up the procurement of RD&T^2 and still meet the goals of transparency, fairness and objectivity in the awards? Furthermore, are there mechanisms that improve agencies' efficient access to a large spectrum of research competencies?

In this paper, the authors discuss one such mechanism that can be used to facilitate the procurement of RD&T^2 services in a seamless manner. The mechanism involves a strategic partnering between transportation agencies and academic/research or consulting community through consortia. The paper outlines benefits and shortcomings of such a strategic partnering. The potentials for an agency and a consortium to become "Learning Organizations" through such partnerships are also discussed. The authors' discussion draws significantly from their experience in running such a consortium. This consortium is known as the Transportation Infrastructure Research Consortium (TIRC) that developed a strategic partnering with the New York State Department of Transportation (NYSDOT). TIRC is a consortium of 10 universities and two research organizations in New York State. Currently, TIRC is in its sixth year of operation. While the partnership is still in the learning phase, there are a number of useful past experiences that the authors discuss. They not only describe this partnership, but also analyze the reasons for its success and further point out possible improvements and pitfalls in such a relationship.

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1. INTRODUCTION

The current trend of rapid changes in technology is a challenge to any agency that wants to remain efficient in the delivery of its technical services. This trend has made research and development (R&D) an essential element of many technical agencies. Such agencies are also looking for all available new knowledge, whether developed by their own R&D or by outside agencies, so as to remain up-to-date in their practice. This latter part constitutes "institutional or organizational learning" and is normally accomplished through effective technology transfer (T^2) of new knowledge into routine practice.

In this paper the authors discuss traditional and emerging trends in the methods of delivering research, development and technology transfer ($RD\&T^2$) to transportation agencies responsible for transportation infrastructure, operations and services. In particular, the authors discuss, in general terms, the merits and pitfalls of each method. A particular emphasis is devoted to the method of strategic partnering between transportation agencies and the research/academic community via consortia, and potential for this partnering in fostering the creation of "learning organizations". The authors finally present a case study of a strategic partnering effort in the delivery of $RD\&T^2$ to the New York State Department of Transportation (NYSDOT). They discuss the circumstances that led to its formation and the lessons learned during its first five years of operation.

2. RD & T^2 INTO TRANSPORTATION AGENCIES

Before looking at the various methods of delivering $RD\&T^2$, the authors will first discuss the objectives of research activities; development work and technology transfer programs, in the context of this presentation.

2.1 Research Objectives

The objectives of research are to study and solve problems and to push the envelope of knowledge in order to generate new knowledge and new paradigms. The new knowledge and paradigms generated by research may or may not be of practical use. Research activities do not necessarily guarantee useful or new knowledge. The results of research may very well be that there is nothing new to report or that a certain approach to solving a problem does not work or that the problem is insolvable. Typically, this happens only in a minority of research efforts. However, in order to advance in technology and improve the efficiency of processes this possibility is necessary.

2.2 Development Objectives

New knowledge generated by research (basic research) or old knowledge whose time has come for implementation can be tested for application with the objective of increasing efficiency or effectiveness of products and/or services. This step is sometimes referred to as *applied research*. Development work may result in usable or non-usable knowledge. The non-usable development work often is a result of factors external to the technology itself. For example, basic research may yield knowledge that can be applied to improve a particular operation, e.g., automatic (electronic) toll collection. However, if a particular community rejects the use of such facilities for fear of intrusion of privacy, that technology may not be useful for implementation in that environment.

The above distinction between research and development can be represented graphically as shown in Figure 1 below.

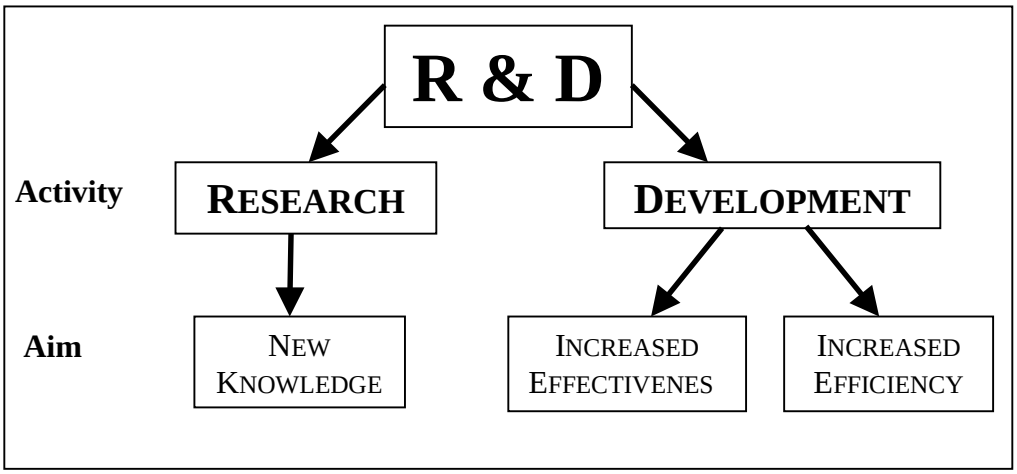


Figure 1. Different objectives between research and development. [Ingvarson – 1999]

2.3 Technology Transfer (T^2) Objectives (Fostering Learning Organizations)

Howe [1998] defines technology transfer as *"…an actively managed change process in which concepts, methods, skills, or equipment developed in one venue are implemented in another."* The technology being transferred is often a result of R&D. There are three key tenets to successful technology transfer. These tenets should ensure that the venue (agency, country, professional practice, etc.) receiving the technology would:

- adopt the technology,
- apply it to implement change and increase efficiency,
- learn from it in order to inspire further development or improvement of that technology or new technologies.

The last tenet of T^2 implies that organizations to which technology is transferred should constitute "learning organizations." Senge [1990] gives a detailed discussion of the management concept of learning organizations. In general terms, however, Gifford and Stalebrink [1999] define organizational learning as *"…the capacity of people in organizations to assess the results of their efforts (*or transferred technology*) …and then use these new ideas to change established practices."* The concept of organizational learning is not always one-way. Both the agency receiving technology and the agency transferring the technology have opportunities to learn, given the right environment. Later in the paper, when strategic partnering between professional agencies and academic/research community is discussed, it will be shown that the process of organizational learning is necessarily a two-way process.

Having defined research, development and technology transfer, let us now look at how transportation agencies can procure RD&T^2 most efficiently.

3. PROCUREMENT OF RD&T^2 BY TRANSPORTATION AGENCIES

3.1 In-House

Transportation agencies have their own divisions, offices, programs or bureaus that direct R&D. These in-house R&D bodies employ highly trained professionals who carry out or direct R&D in their organizations. They also form a body of technical experts that oversee R&D services brought in by outside vendors. The dilemma has been to determine the size of these in-house R&D bodies. Since all transportation agencies deal with a multitude of technical fields, ranging from engineering to law to environmental concerns, it would be unwise and prohibitively expensive for them to staff their R&D entities with all the technical personnel and equipment needed to carry out R&D in-house. Therefore, a proper balance between in-house R&D and contract R&D is needed. There has been a lot of debate within transportation agencies as to what this proper balance is. This paper will not go into this discussion.

3.2 Traditional Contract RD&T^2

Contract research has greatly complemented R&D in transportation agencies. This vehicle of acquiring RD&T^2 has often proved to be cost-effective in the sense that transportation agencies are able to tap onto academic/research and consulting organizations with their vast reservoir of knowledge and technology at relatively low cost. Therefore, most RD&T^2 that require specialized technology or experts has often been contracted to outside organizations. As technology advancement continues to grow at a fast rate, procurement of contract RD&T^2 becomes even more necessary in order to take advantage of the existing expertise that resides outside transportation agencies. However, besides the advantages of contract research outlined above, there are two major shortcomings in the traditional way of procuring contract research. The shortcomings are:

(a) slow speed of acquiring RD&T^2 inherent in the government procurement procedures,
(b) lack of commitment by providers of RD&T^2 to see themselves as part of the stakeholders to the advice and products offered to transportation agencies.

3.3 Speed of Acquiring RD&T^2

Transportation agencies are usually public (government) entities. Therefore, procurement of goods and services (if not available in-house) by these agencies must follow strict procedures that ensure transparency (accountability), fairness and objectivity. However, these procedures have often slowed down the process of procuring RD&T^2. The time taken from problem statement to contracting and project execution has often been too long, thereby making such agencies slow to acquire RD&T^2 services and to keep abreast with the fast-changing technology. Kelman [1990] observed that government *"…procurement procedures* (that) *emphasize fairness and objectivity in making awards, often frustrate the desire of those charged with delivering services for speedy, technically sound implementation."* Therefore, the question has been: are there mechanisms that would speed-up the procurement of RD&T^2 and still meet the goals of transparency, fairness and objectivity in the awards?

3.4 Commitment of Providers of RD&T^2

Unlike construction projects that are contracted out by transportation agencies where products are known in measurable units and benchmarks can be specified precisely to the contractor, RD&T^2 services are rather hard to quantify and value. Some research results may not be useful at all but are a necessary part of RD&T^2. This implies that outside agencies that provide RD&T^2 to transportation agencies ought to develop an understanding, appreciation and commitment to the operations of transportation agencies, so as to provide them with

sound advice and research products. If providers of RD&T^2 do not have this understanding, there is a danger of generating RD&T^2 results that are piecemeal and myopic in nature.

The two shortcomings discussed above speak in favor of transportation agencies to develop a long-term relationship through special strategic partnering with the academic/research/consulting community in order to have strong commitment to excellence on both parts without contravening sound procurement procedures in the process of acquiring RD&T^2.

Furthermore, such a partnership will, over time, streamline the development of a better and more useful research products. This is because the partners begin to better understand each other's strengths, modus operandi, needs, and limitations, not to mention the political environment in which they operate. One such strategic partnering vehicle is the use of consortia.

4. STRATEGIC PARTNERING IN THE PROCUREMENT OF RD&T^2 VIA CONSORTIA

4.1 Voluntary Consortia

A consortium is a voluntary body comprised of organizations with common interests. Academic/research organizations may form such consortia. Consulting companies may form consortia or providers of specialized products may also do so. Gifford and Stalebrink [1999] described a voluntary consortium as *"…a special type of strategic partnering in which organizations join together to share knowledge and experiences on a voluntary basis.* They continue to say that … *the voluntary aspect is emphasized and refers to the ability of the participants to come and go, with minimal dependence on formal contracts."*

Transportation agencies can enter into partnership(s) with providers of goods and services via such consortia. With such partnership, each consortium may create and transfer knowledge and technology seamlessly between the agency and consortium members. A transportation agency may develop multiple partnerships with, say, a consortium that provides RD&T^2 (e.g., universities and research institutions), one that provides consulting services, and/or one that provides technical services (such as electronic toll collection). Although membership in a consortium is voluntary, in order to maintain proper government procurement procedures, transportation agencies should enter into such partnerships with consortia through open competitive bidding and formal contracts of specified durations.

This contracting process results in an umbrella contract between a public agency and a consortium and may take long to execute, since proper procurement procedures have to be followed. However, once an umbrella contract is in place (say for a duration of 5 years), then all projects that go to this consortium become task orders that should take minimal time from problem statement to execution. In a consortium comprised of several organizations, the task orders are allocated to individuals or organizations through a competitive process. However, this competitive process for distributing task orders can be streamlined time-wise, since consortium administration is not likely to be a government entity.

4.2 Consortia as Learning Organizations

Consortia, especially those providing RD&T^2, have unique opportunities for their members to learn from each other. This learning process can be three-pronged:

- The transportation agency has long-term relationship with providers of RD&T^2 and can easily tap into this large reservoir of knowledge and technology for its staff to learn state-of-the-art knowledge and trends for the future of technology, at relatively minimal cost.
- Institutions providing RD&T^2 have a unique opportunity to learn, from practicing professionals of the transportation agencies, the pressing practical problems that need research and development. It gives academic and research community an opportunity to deal with real-life problems.
- The academic and research organizations tend to be very competitive among themselves, which often hinders cooperation among researchers. Partnering through a consortium tends to bring together researchers from different institutions in order to work on task orders that require multiple skills. This opportunity fosters leaning to take place between institutions comprising the consortia. Researchers from the various consortium members themselves become stakeholders in the consortium and its partnership with the transportation agency.

For a strategic partnering to work effectively, it is important that the learning process be two-way. For example, besides acquiring RD&T^2, transportation agencies should also acquire an understanding of how academic/research institutions operate, such as reliance on graduate students and academic calendar in the timing of projects. This can be achieved by merely hoping that agency professionals would know about this process by virtue of them having gone through college. However, the best way to achieve this is to invite key transportation agency personnel into institutions as professional colleagues (adjunct faculty, guest lecturers or visiting researchers) rather than students. This latter method achieves two purposes. The first one is that it taps knowledge from practicing professionals into the classroom or research facility (academic/research community). The second benefit is that these transportation agency professionals, having worked with students and research entities, develop an appreciation of the constraints facing these providers of RD&T^2. This two-way learning process is likely to create a true partnering between the consortium and the transportation agency rather than the consortium being a mere provider of RD&T^2.

One such strategic partnering in the provision of RD&T^2 is in place in New York State. It is known as Transportation Infrastructure Research Consortium (TIRC). The following is a description of this consortium that provides RD&T^2 to New York State Department of Transportation (NYSDOT). In the next section, an attempt is made not only to describe such a partnership, but also to analyze the reasons for its success and to further point out possible improvements in such a relationship between a state DOT and a consortium of research institutions.

STRATEGIC PARTNERING BETWEEN NEW YORK STATE DEPARTMENT OF TRANSPORTATION AND ACADEMIC/RESEARCH COMMUNITY:

EXPERIENCE FROM FIRST FIVE YEARS OF OPERATION

A BRIEF HISTORY OF TRANSPORTATION RESEARCH IN THE NEW YORK STATE DEPARTMENT OF TRANSPORTATION

It will be useful to provide a brief historical context in which the partnership described in this paper developed.

In the late 1980's, a new Director was chosen to head the NYSDOT "Engineering Research and Development Bureau. His charge was to develop a staff highly skilled in three core engineering disciplines: pavements, bridges, and statistical applications. The thrust was to create an in-house cadre of true experts who could be relied upon to research the most pressing issues within this narrow framework.

That was accomplished and it worked for its intended purpose until 1991, at the same time the U.S. Congress passed the "Intermodal Surface Transportation Efficiency Act"(ISTEA), one of a succession of "surface transportation acts", typically done on a six-year cycle. ISTEA was landmark legislation in many ways, not the least of which was its impact on the federal funds available to support state operated highway research programs. Federal support of state research comes in the form of the "State Planning and Research" (SP&R) program, historically found in all surface transportation acts and has been a specified percentage of the aggregate of most federal highway assistance to the 50 states in the USA.

ISTEA made two significant changes that impacted the level of funding the "Research" portion of the SP&R program. First, it significantly increased the total level of federal highway aid to the states and second, it required that 25% of SP&R funds be spent on research. As the result, national funding of the SP&R program jumped from $153 million in 1991 to $278 million in 1992.

New York and all other states were faced with a challenge as to what to do with the added funding and, more importantly, how to do it. New York, like most states, decided to expand its research effort and more specifically to direct the expansion to outside providers. The idea was to expand the capability of the research organization to study problems outside the confines of engineering to the expanded definition of "transportation research". The second concept was to avoid trying to staff an in-house research staff with "universal" expertise, which was considered both infeasible and imprudent.

"Engineering" was dropped from the Bureau name. The Bureau name was changed to "Transportation Research and Development Bureau". To procure research beyond its capability, the Bureau began to use a system called the "Contract Research Program". When needed, Request for Proposals (RFPs) were prepared for individual research problems. These were advertised, a principle investigator chosen, an individual contract negotiated and executed. The system worked but it was expensive to manage and very slow to produce a usable product from concept to completion. Frustrated executive management charged the Bureau to propose a more efficient means to that end.

New York was blessed with a multitude of academic engineering institutions and private research providers. However, because of this and, unlike many other states, there was no clear research partner with which New York might establish a long-term relationship. The Bureau suggested the formal creation of a consortium capable of researching the broad spectrum of potential transportation research. Its proposal was accepted. An RFP was developed and advertised in the fall of 1994. It was subsequently released to more than 80 requesting organizations. In April of 1995, Cornell University and its proposed "Transportation Infrastructure Research Consortium" (TIRC) was designated as the preferred contractor.

THE TRANSPORTATION INFRASTRUCTURE RESEARCH CONSORTIUM - TIRC

TIRC Inception

The New York State Department of Transportation (NYSDOT) sought to establish formal mutually beneficial partnership with New York State colleges, universities and research organizations. This partnership aimed at utilizing the knowledge and skills at the colleges and research organizations to complement those of NYSDOT staff and create an atmosphere of continuous improvement in the fields of engineering, operations, public transportation, management and finance, public policy and human resources. This partnership was perceived as an opportunity to develop more effective ways to maintain the state's transportation system, and foster better interaction with the university community.

A competitive RFP was developed and proposals were solicited for a research consortium comprised of a minimum of three colleges, universities, or research organizations. The NYSDOT recommended a Cornell University-led research consortium team for contract award. The Team was comprised of the following universities and research institutions:

- Cornell University (lead institution);
- Brookhaven National Laboratory,
- CALSPAN Corporation/University of Buffalo Research Center,
- City University of New York;
- Nelson Rockefeller Institute of Government,
- New York University,
- Polytechnic University of New York,
- University at Buffalo (State University of New York - SUNY),
- SUNY-Maritime College,
- SUNY- Stony Brook.

The Consortium came to be known as the Transportation Infrastructure Research Consortium (TIRC).

Partnership Goals & Objectives

The goals of the partnership were to complement the NYSDOT's planning, design, construction, operation, and management capabilities of New York's transportation network, through creating a cross-functional and multi-disciplinary approach to problems, and identifying state-of-the-art innovative solutions to a wide range of transportation issues. The Scope of Service for the TIRC contract outlined objectives for the research, technology transfer and consultation component of the agreement.

The research component of this partnership aimed to address NYSDOT needs of basic and applied research in the areas of engineering, operations, public transportation, management and finance, public policy and human resources, so as to complement other NYSDOT-sponsored research activities. The objectives of the research component partnership were to:

(a) Identify a long-range program of basic and applied research tailored to the NYSDOT's needs;
(b) Ensure timely and prompt response to high priority issues;
(c) Introduce real life issues faced by the NYSDOT to the university environment and utilize the expertise and skills available at the university level to address those problems, thus developing better and more effective ways of improving the state's infrastructure and mobility; and
(d) Execute an expeditious research management process to minimize the time between project conception and execution (i.e., streamline the process).

The technology transfer objectives were to disseminate the knowledge gathered during research and facilitate the adoption of research products. The intent is not only to get the knowledge and techniques into the hands of those who need it, but also to deploy appropriate mechanisms necessary to foster the adoption of such knowledge and techniques. Typical mechanisms used to facilitate the adoption process include short courses, seminars, training, presentations, etc. Technology Transfer services are meant to:

(a) Disseminate the results of NYSDOT-sponsored research;
(b) Provide intensive, comprehensive, and responsive information exchange in coordination with the Local Technical Assistance Program (LTAP), and University Transportation Research Center (UTRC) programs,
(c) Keep the NYSDOT abreast of current and emerging technologies and knowledge conceived through national and regional research programs;
(d) Facilitate adoption of technology transfer products (i.e., products conceived through research).

The objectives of the consultation component were to respond in a timely and prompt manner to short-term and urgent departmental needs that might arise.

TIRC's Organizational Structure

Cornell University is designated as the lead institution. A Consortium administrative entity assumes overall management responsibility for all activities of the consortium, including management of the research, technology transfer, and consultation activities with member institutions, and coordination between members of the consortium and the NYSDOT. The Lead Institution coordinates contractual agreements, performs day-to-day administrative functions, ensures accountability of all participants, resolves any problems that might arise, maintains close coordination with the NYSDOT, stimulates active participation of Consortium members, and ensures that all legal and funding terms of the Consortium are adhered to by the contractors.

The Transportation Research & Development Bureau (TR&DB) directed the first phase of TIRC. Its responsibilities included ensuring coordination between the NYSDOT and the Consortium, and enforcing accountability, and providing assessment of administrative and technical performance of the partnership.

Technical Working Groups (TWGs) were established for each research project. These TWGs consist of experts from the affected program areas in NYSDOT who were designated to

direct individual projects. Their role is to answer questions, provide overall management, technical supervision and secure information reasonably available from the NYSDOT.

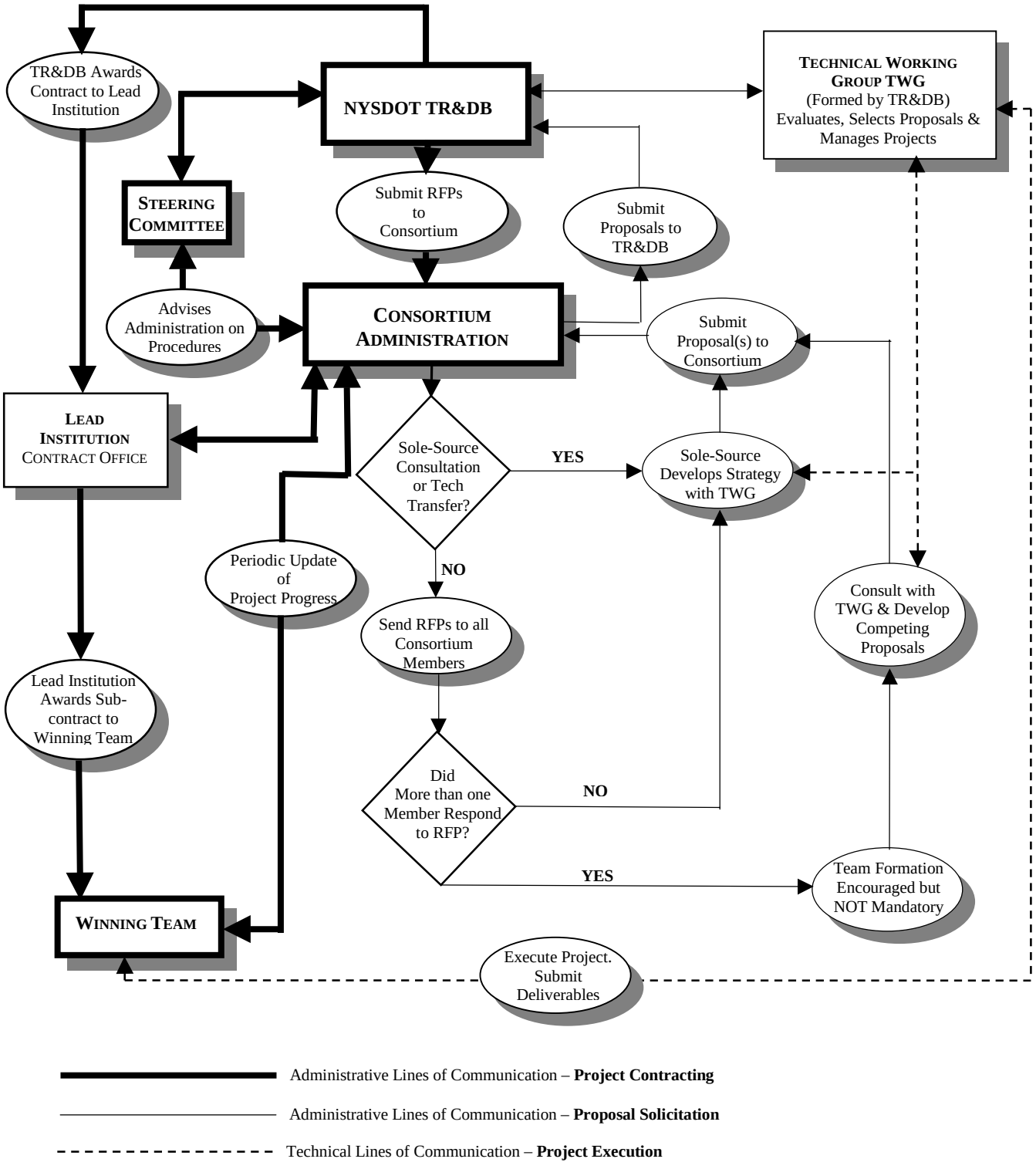
Processing a Research Project from Conception to Implementation

The following is a typical procedure used in processing projects through the Consortium:

1. A research project is typically identified by a departmental program area(s) that is the main beneficiary.
2. The Director of TR&DB then notifies the Consortium in writing of the request for the project.
3. Informal discussions between TR&DB and the Consortium's administration are held to ensure a clear understanding of the project and clarification of any ambiguities.
4. The Consortium administration solicits expressions of interest and qualification statements from interested Consortium members.
5. The Consortium administration actively encourages team formation among interested institutions and solicits research proposals from teams (and individual Consortium members)
6. The Consortium administration submits proposals that, in its opinion best meet the NYSDOT's needs. The proposals will include a detailed scope of service; identification of tasks and personnel, schedule; cost estimate; and a plan for transferring research results.
7. The NYSDOT reviews the submitted proposals, selects the best one, or requests a re-submission if it believes the proposal(s) to be of unsatisfactory quality.
8. Upon approval of the project, the NYSDOT authorizes the performance of the project, and the project is initiated.
9. A Technical Working Group (TWG) comprised of experts from affected program areas is formed to guide the execution of the project.
10. Upon completion of the research project, the research team develops a technology transfer strategy that identifies target audience within the NYSDOT, outlines scope and schedule of technology transfer efforts needed to facilitate transfer, and indicates technology transfer mechanisms that will be utilized.

In addition to research projects, the consortium also addresses the NYSDOT's need to transfer products conceived through others' research, and responds to quick turn around and short-term pressing problems and task orders. Figure 2 presents a flowchart of the process and operation described in the previous section.

Figure 2. Transportation Infrastructure Research Consortium (TIRC) Operation



KEY FINDINGS ABOUT THE NYSDOT-TIRC PARTNERSHIP

Opportunities and Strengths

- *The Advisory Role of TIRC in the Formulation of a Research Agenda*
  The NYSDOT envisioned the role of TIRC in program development as advisory. The NYSDOT's Research Advisory Panel was intended to draw its membership from TIRC. Although never formally established, the duties of this ad-hoc panel were to:
  (a) Contribute to the identification of strategic needs facing the NYSDOT,
  (b) Respond to surveys conducted by TR&DB
  (c) Participate in Research & Development (R&D) brainstorming sessions;
  (d) Support and reinforce the functions of the R&D Council and act as an advisory expert panel available on an as-needed basis.

  Members were intended to serve as non-voting observers to ensure that program formulation is consistent with broad policy directions set by NYSDOT's executive leaders.

  There is no doubt that the wealth of specialized and varied expertise available at TIRC is an invaluable resource to NYSDOT. The partnership provided a much-needed bridge between the world of theory and the world of practice. TIRC has submitted a collective portfolio of projects to NYSDOT for consideration. The portfolio shaped and informed the program agenda.

- *Streamlining the Process*
  The Consortium utilizes an ideal mechanism created specifically to execute projects that require prompt action and where delays in approval would result in loss of valuable funding. Instead of lengthy contractual procedures, which a project traditionally undergoes before execution, an umbrella contract is executed and all individual projects are processed under this contract as task assignments. This considerably streamlines the procurement process.

  An example of a "high priority" project which required a prompt response and a streamlined contracting process was an Intelligent Transportation System (ITS) research & development project (Integrated Incidents Management System (IIMS). Delays in processing this project through the traditional channels would have meant loss of valuable federal funds. Selecting a vendor through the traditional means would have jeopardized the NYSDOT's access to federal Congestion Management Air Quality (CMAQ) funds estimated at $3 million. This project, included in the Transportation Improvement Plan (TIP), was close to being terminated before it even started unless its contracting channels were streamlined. Through TIRC, the State was not denied the benefits of this project. It preserved its competitiveness in the area of ITS development, and enabled NYSDOT Region 11 (New York City Area) to accomplish its operational goals.

Weaknesses and Threats

- *Lack of TWG Commitment to Project Implementation*

Many TWG members were not familiar with the procedures, and were unclear about their functions despite the provision of a detailed and comprehensive document, which outlined such functions and laid out the guidelines, and despite the constant interaction between members of the Transportation R&D Bureau with them. There is often a lack of interest in moving a project along, or an initial interest followed by a sudden disinterest in project conduct. This meant exerting a great deal of effort on TR&DB's side to instill interest in the project and lobby for its implementation, emphasizing the benefits that the program will likely reap. The absence of a sufficient level of commitment can be resolved by involving members of the research staff on each TWG. This route was initially rejected since it was felt that it would deny TWG the sense of ownership of the project, and would therefore, erode commitment to the project. In some instances, the lack of program area commitment has led to termination of a very promising project. In at least one incident, TWG has opted to terminate a project abruptly without compelling reasons.

- *Constraints of the Academic Cycle*

Timing of the research must be consistent with the academic year when graduate students are available to provide critical support to a research project. This can be overcome by utilizing the in-house researchers to provide in-kind support to the investigative team, such as the collection of data and development of reports. This can reduce TIRC's cost and overcome concerns of timing and the academic year.

- *Significant Modifications of Project Objectives (Scope-Migration)*

Program areas sometimes shift project objectives significantly and modify objectives during project mid-course. This phenomenon is sometimes known as *scope-migration*. While a moderate modification should be expected to accommodate the unpredictable and changing external environment and shifting political priorities, a more substantial divergence creates confusion, resentment on the part of the researcher, and ultimately a strain on partnership ties. In at least one incident, the Technical Working Group has opted to shift course abruptly. Enhancing communication between the TWG and the Principal Investigators during proposal preparation and project scoping can mitigate this situation. The TWG must take responsibility and accountability for the project and must develop clear project objectives prior to the beginning of the project and communicate these objectives to all stakeholders, so that substantial modifications occur only at the early formative phases of the project.

- *Continual Modifications of Project Deliverables (Scope-Creep)*

Another source of frustration can result from the TWG liking the products (deliverables) so much that they would ask the investigators to try ever-so-slight expansion of the current results that ultimately lead to additional effort for the investigators that was not budgeted for. This phenomenon is known as *scope-creep*. If TWGs and investigators are not careful in defining precisely what the deliverables are supposed to be, there is a danger that scope-creep may occur. At least one TIRC project has shown signs of scope-creep.

- *Change of the Principal Investigator*

Some projects have experienced a change in the principal investigator. While such change is beyond anyone's control, it results in substantial delays. The process it takes to replace the investigator, obtain TWG's approval, and get the project back on course represent serious obstacles to project progress.

- *Lack of First-Instance Funding*

While the program relies heavily on Federal State Planning & Research (SPR) funding, the nature of how these funds flow into the program requires that the state provide first-instance funds and then gets reimbursed. The absence of sufficient first-instance funds has been a stumbling block, not only in providing healthy funding streams that would support the execution of projects, but in regularly collecting federal funds appropriated to research as well. This vicious cycle has resulted in substantial accumulated federal funds that the state was unable to access, and channel to the program. Reinforcing commitment of NYSDOT top management to research can mitigate this situation.

- *Lack of Accountability to Implementation*

Good technology does not sell itself. Research without implementation is of no value to NYSDOT. TR&DB has always emphasized that implementation is a collective effort between the investigator and the NYSDOT. Without advocates for product implementation, such products will remain trapped on the pages of the final report. If implementation is a primary goal, then delivery of final reports does not represent the end of the journey. This principle needs to be communicated more clearly to all stakeholders. Budget needs to be allocated for implementation activities. An implementation plan should be an integral part of the project's scope of service, and both the investigators and the TWG need to be accountable for implementing the products.

CONCLUSIONS

Research constitutes an investment that is essential to the NYSDOT's mission, and is vital to its leaders. Research is a key to moving the NYSDOT forward through introducing calculated, informed decision-making. It provides critical services supporting DOT functions. In recent years, the Transportation Research & Development Bureau has expanded its program beyond traditional engineering parameters in response to customer needs. To complement its efforts, it has created partnership mechanisms with a consortium of ten universities and research institutions.

The TIRC-NYSDOT partnership has proven to be a valuable resource in effectively and efficiently addressing existing and anticipated problems. It provided access to specialized expertise, equipment and facilities, which are not otherwise readily available. It is convenient and mutually beneficial arrangement. The competitive nature of project selection to which the program is committed, preserves the integrity of the process while eliminating the long-widening maze which a project contracted out through the traditional means has to undergo. Lengthy contracting periods for individual projects were virtually eliminated.

The first five years of the TIRC-NYSDOT partnership were successful. While the process of integrating TIRC into the NYSDOT experienced expected growing pains, at the end of phase I, this partnership is stronger than ever. A solid foundation of trust and interdependence between partners was established. With patience and perseverance, players have been able to harmonize relations and capitalize on each other's strengths. Time was critical in allowing cohesive relations to be conceived within the Research Consortium itself, between administrators and members, and among members, as well as between the Consortium and the NYSDOT. This harmony was crucial to the quality of Consortium responses to NYSDOT research needs.

Experience has proven that longer-term partnerships are more effective than short-term models. Partnerships typically experience day-to-day real and perceived problems. With time, these problems are resolved, as operating relations between involved parties normalize. As those parties overcome complexities of interactions and better understand each other's vision, mission, goals, and operating environment, the partnership strengthens, producing mutually beneficial results. Past experience has proven that with time solid partnerships grow and flourish.

RECOMMENDATIONS

Principles of Strong Partnership:
Bridging the Organizational Divide and Implementing Strategies for Success.

Successful partnerships require the following:

1. Establishing clear goals defined at the outset in order to ensure clarity among partners, achieve desired results and help guide the partnership through obstacles and challenges.

2. Aiming to achieve positive results and regularly measuring progress. Regularly measuring results allows partnerships to assess whether activities and strategies are meeting goals, and what changes should be made to make the partnership efforts more effective.

3. Including key stakeholders from the beginning. Partnerships are most effective when they are able to draw from a broad range of perspectives, resources, and expertise. Partnerships can gain broader public and private support for their efforts through the constituents that each partner represents and supports.

4. Establishing clear governance structures that define partner roles and responsibilities. Establishing an effective governance structure is essential to successful partnership management. It is equally important to define the various roles that partners will play and to make sure that all partners understand and accept these roles.

5. Setting and adhering to ground rules that guide the partnership in its work. Partnerships should begin with mutually agreed-upon ground rules. Such ground rules might include how partners will define and measure success, conduct meetings, communicate with each other, share information, and make decisions.

6. Being flexible, and adapting to changing conditions and resources. Partnerships must be able to change in response to emerging needs and to take advantage of new opportunities.

7. Enabling all partners to benefit by drawing on their strengths and contributions. Each partner brings different strengths, knowledge, and resources to the partnership. Sensitivity to these attributes will cement working relationships among partners and allow the partnership to draw on a broad range of resources and expertise.

8. Working to maintain momentum and sustaining the efforts over time. The most successful partnerships plan right from the beginning for how they will maintain

momentum and sustain their efforts. Creating a sense of shared ownership and collective purpose increase the likelihood that partners will stay involved over the long run.

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